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Chung et al.

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(54) **UNIVERSAL SERIAL BUS DEVICE AND UNIVERSAL SERIAL BUS SYSTEM INCLUDING THE SAME**

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G06F 13/00 (2006.01)

(52) **U.S. Cl.** **710/313**

(58) **Field of Classification Search** 710/313, 710/314

See application file for complete search history.

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English language machine translation of KR 10-2007-0008590.*
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Wireless Universal Serial Bus Specification; May 12, 2008, Revision 1.0.

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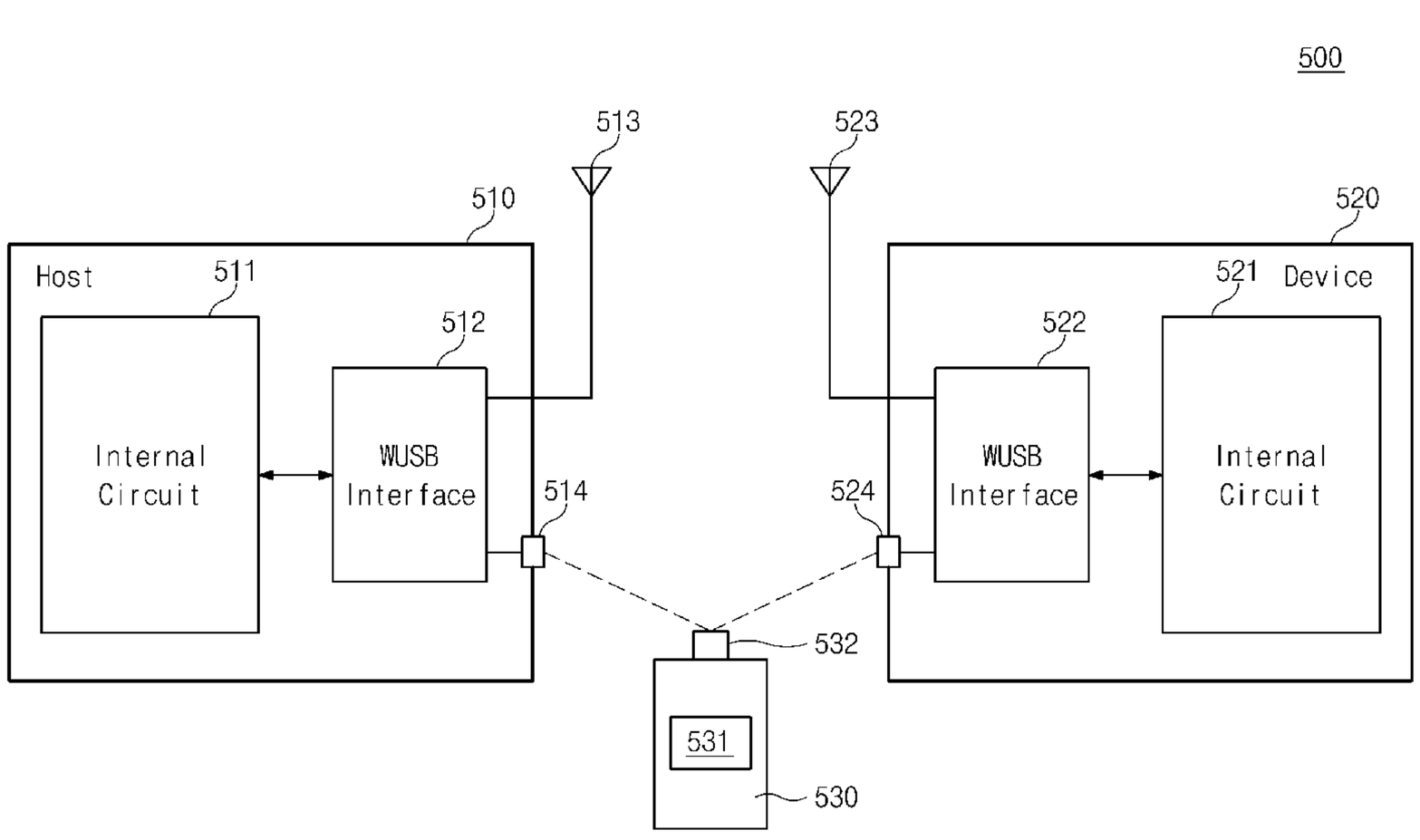
(57) **ABSTRACT**

A Universal Serial Bus (USB) device includes an internal circuit and an interface circuit. The interface circuit is configured to interface the internal circuit and an external device for wireless USB (WUSB) communication and USB communication. The interface circuit includes a WUSB module enabling the WUSB communication, an on-the-go (OTG) module enabling the USB communication, and an interface module configured to selectively control the WUSB module and the OTG module to interface the internal circuit and the external device for the WUSB communication and the USB communication.

8 Claims, 6 Drawing Sheets



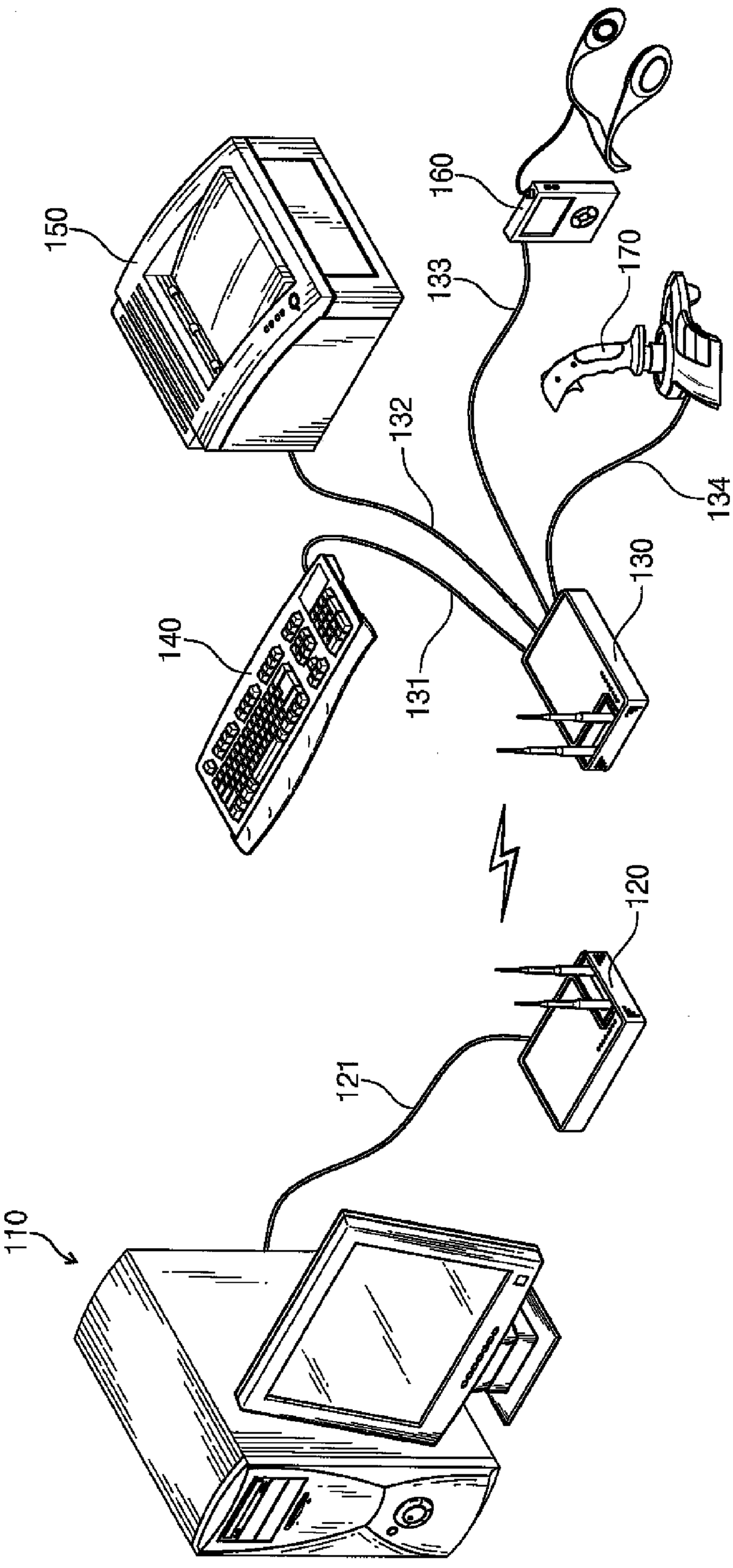


Fig. 1
(Prior Art)

Fig. 2

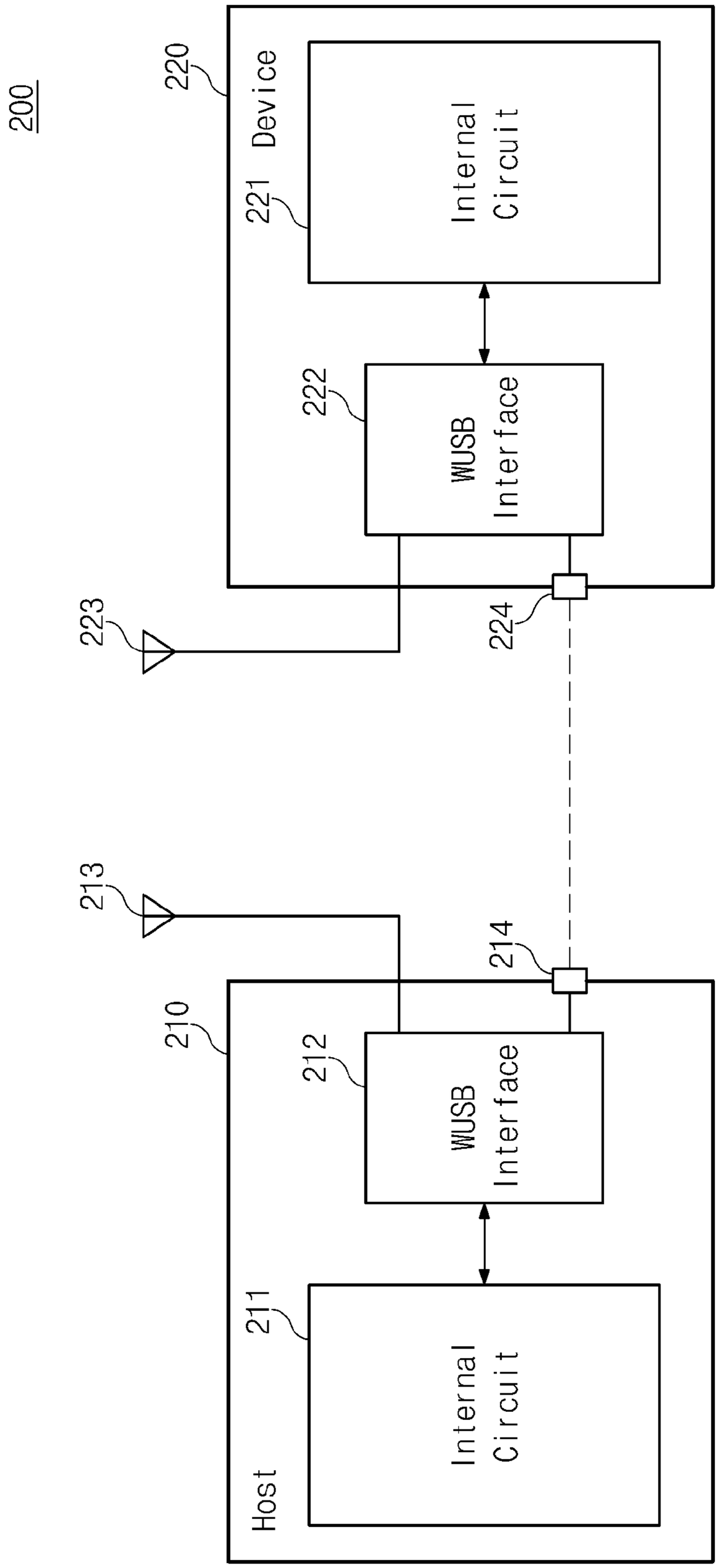

200
220
Device
221
Internal Circuit
222
WUSB Interface
223
224
213
214
210
212
WUSB Interface
211
Internal Circuit
Host

Fig. 3

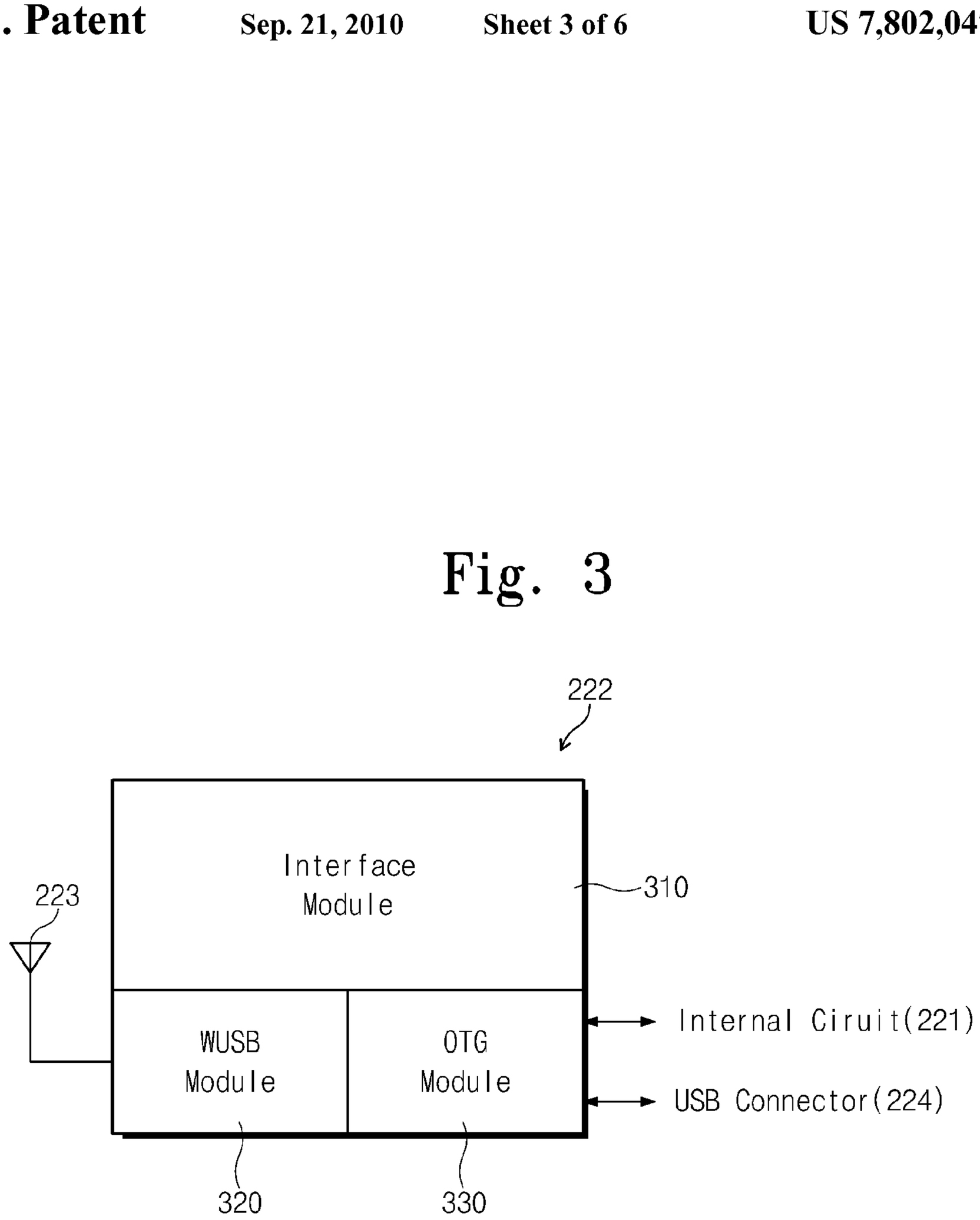

222
Interface Module
310
223
WUSB Module
OTG Module
Internal Ciruit(221)
USB Connector(224)
320
330

Fig. 4

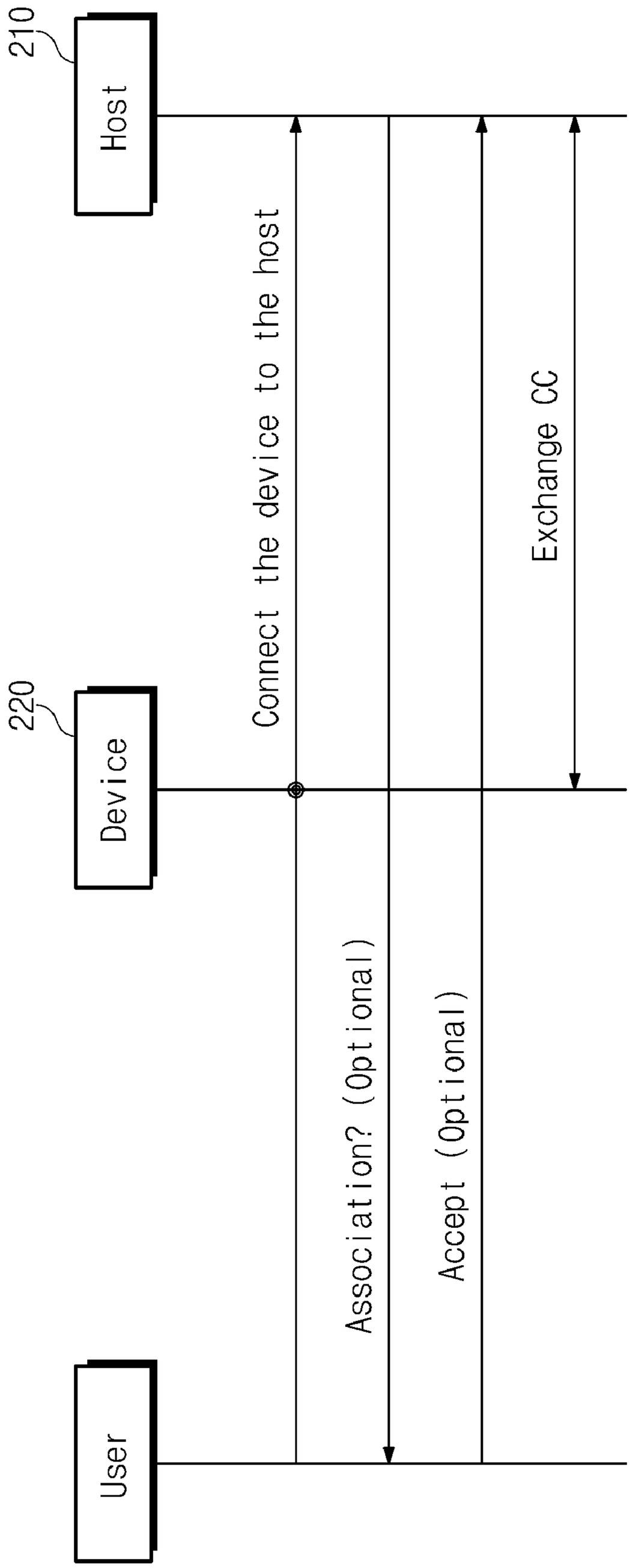

210
Host
220
Device
User
Connect the device to the host
Association? (Optional)
Accept (Optional)
Exchange CC

Fig. 5

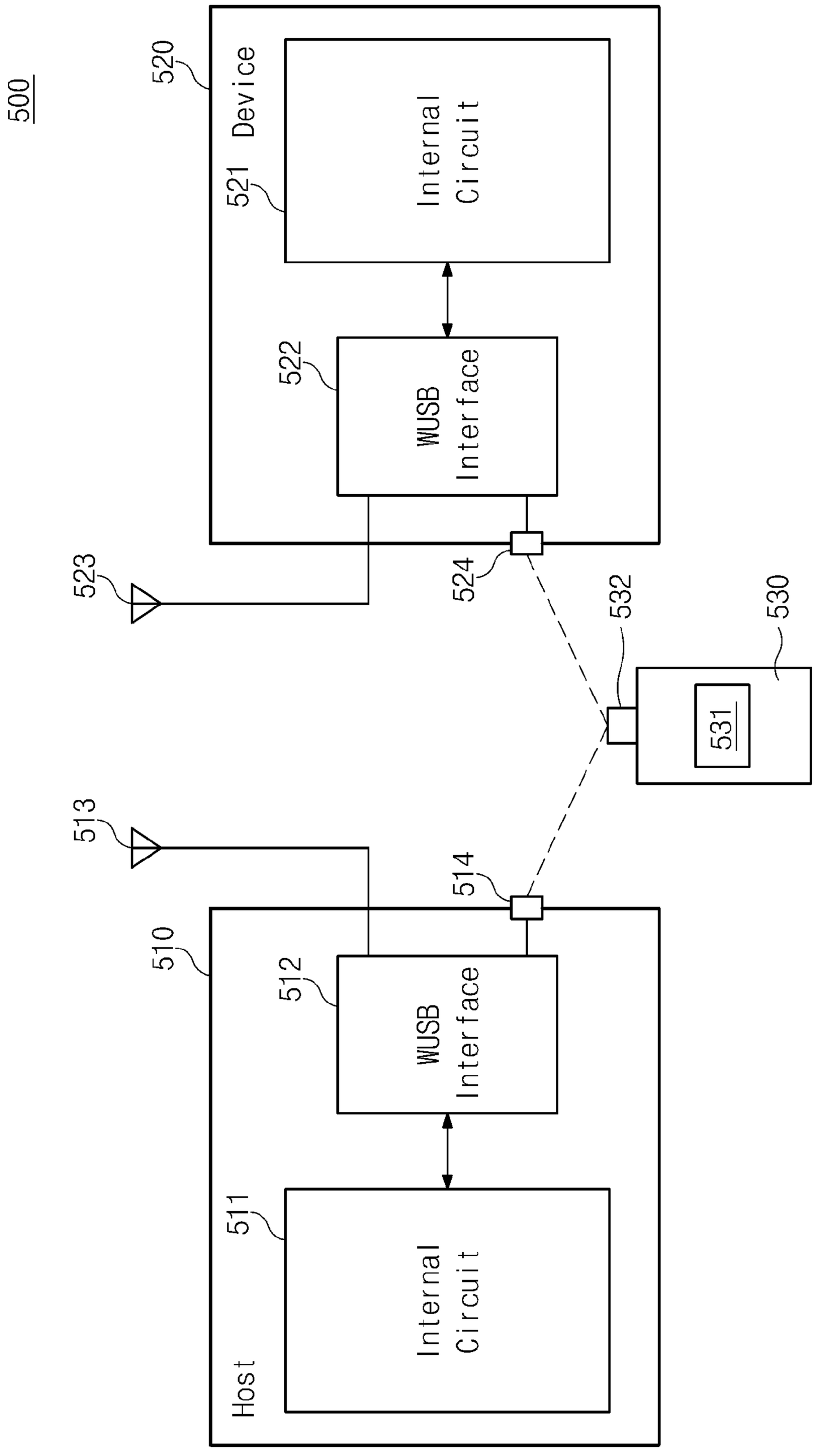
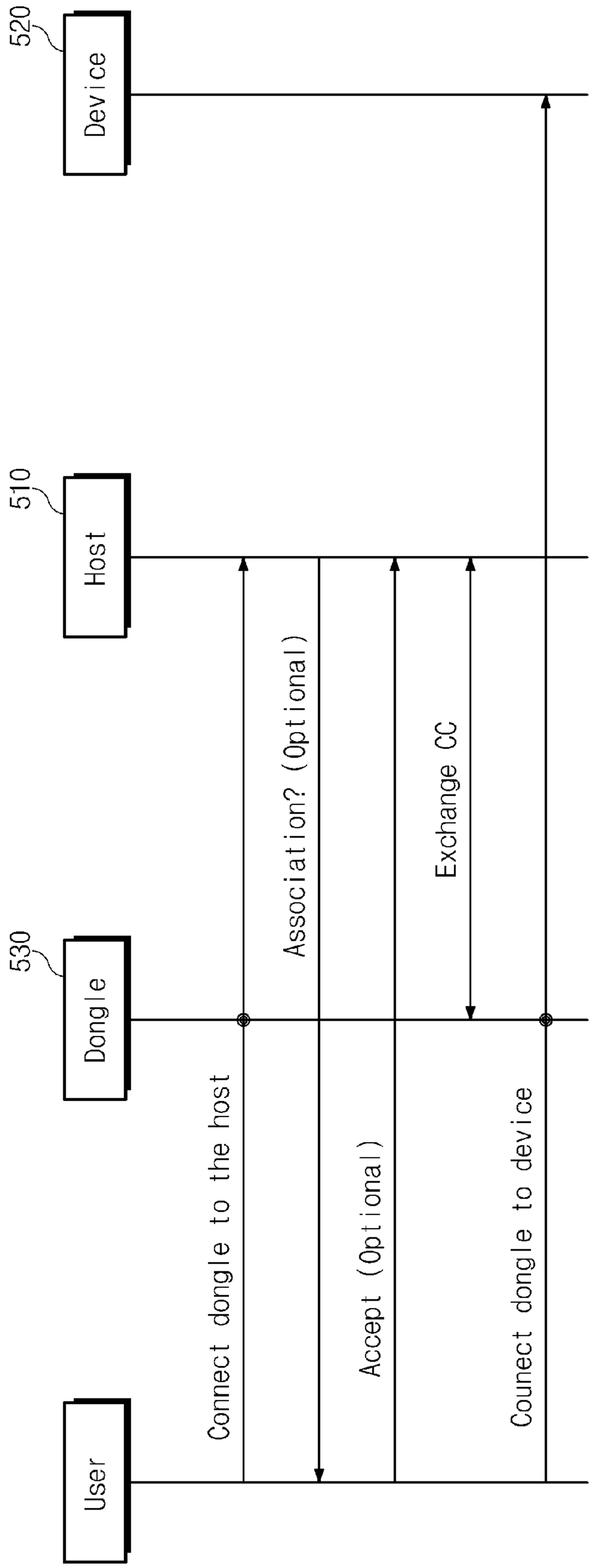

500
520
Device
521
Internal Circuit
522
WUSB Interface
523
524
532
530
531
513
514
510
512
WUSB Interface
511
Internal Circuit
Host

Fig. 6


520
Device
510
Host
530
Dongle
User
Connect dongle to the host
Association? (Optional)
Accept (Optional)
Exchange CC
Counect dongle to device

UNIVERSAL SERIAL BUS DEVICE AND UNIVERSAL SERIAL BUS SYSTEM INCLUDING THE SAME

PRIORITY STATEMENT

A claim of priority is made to Korean Patent Application No. 10-2007-0115037 filed on Nov. 12, 2007, in the Korean Intellectual Property Office, the subject matter of which is hereby incorporated by reference.

SUMMARY

The present invention relates to a Universal Serial Bus (USB) device, more particularly, to a wireless USB communication device.

A USB is a peripheral device of a computer and is widely used as an interface. It includes features such as plug and play (PnP), automated allotment of identification and hot plug, which are not included in a conventional parallel bus. A USB cable only has four lines, including two signal lines, a power line and a ground line. Therefore, cables and connectors may be made smaller, which reduces production cost. Also peripheral devices may similarly be developed at lower cost.

As USB may be applied to various devices, it is becoming standard for connecting peripheral devices to personal computers and lap-top computers. Many recent peripheral devices and portable devices use the USB.

As local wireless technology suitable for connection between devices becomes more widely used, Ultra Wide Band (UWB) is gaining attention as a wireless communication technique. An important application of UWB technology is enabling wireless communications by use of USB 2.0, for example, which is a high-speed serial interface. The specification for wireless communication using USB 2.0 addresses adaptation to conventional software sources. For example, a "wire adaptor" may be used with respect to interfacing conventional USB hosts and devices wireless, as they are.

Exemplary embodiments of the present invention provide a Universal Serial Bus (USB) device that includes an internal circuit and an interface circuit. The interface circuit is configured to interface the internal circuit and an external device for wireless USB (WUSB) communication and USB communication. The interface circuit includes a WUSB module enabling the WUSB communication, an on-the-go (OTG) module enabling the USB communication, and an interface module configured to selectively control the WUSB module and the OTG module to interface the internal circuit and the external device for the WUSB communication and the USB communication.

Other exemplary embodiments of the present invention provide a USB system including a USB host, a USB device configured to connect to the USB host and a dongle configured to connect to each of the USB host and the USB device. The dongle connects to the USB host to exchange connection context (CC) with the USB host, and connects to the USB device to provide the exchanged CC to the USB device. The USB device includes an internal circuit and an interface circuit configured to interface the internal circuit and at least one of the USB host and the dongle for wireless USB (WUSB) communication and USB communication.

BRIEF DESCRIPTION OF THE DRAWINGS

The embodiments of the present invention will be described with reference to the attached drawings, in which:

FIG. **1** illustrates examples of wire adapters in Wireless Universal Serial Bus Specification, Revision 1.0;

FIG. **2** is a block diagram illustrating a USB system, according to an exemplary embodiment of the present invention;

FIG. **3** is a block diagram illustrating a WUSB interface of FIG. **2**, according to an exemplary embodiment of the present invention;

FIG. **4** is a flow diagram illustrating an association process of the USB system of FIG. **2**, according to an exemplary embodiment of the present invention;

FIG. **5** is a block diagram illustrating a USB system, according to another exemplary embodiment of the present invention; and

FIG. **6** is a flow diagram illustrating an association process of the USB system of FIG. **5**, according to an exemplary embodiment of the present invention.

DETAILED DESCRIPTION OF THE EMBODIMENTS

The present invention will now be described more fully with reference to the accompanying drawings, in which exemplary embodiments of the invention are shown. The invention, however, may be embodied in various different forms, and should not be construed as being limited only to the illustrated embodiments. Rather, these embodiments are provided as examples, to convey the concept of the invention to one skilled in the art. Accordingly, known processes, elements, and techniques are not described with respect to some of the embodiments of the present invention. Throughout the drawings and written description, like reference numerals will be used to refer to like or similar elements.

FIG. **1** illustrates examples of wire adapters in Wireless Universal Serial Bus Specification, Revision 1.0. Wireless-USB will be referred to as WUSB, hereinafter.

Referring to FIG. **1**, a host **110** and exemplary devices **140**, **150**, **160** and **170** may communicate wirelessly through wire adapters, such as Host Wire Adapter (HWA) **120** and Device Wire Adapter (DWA) **130**, respectively. The host **110** and the HWA **120** are connected by means of USB connection **121**, and the DHA **130** and the devices **140** to **170** are connected by means of USB connections **131-134**, respectively.

When a user wishes to initially connect the USB host **110** and the USB devices **140** to **170** by means of WUSB, a process for interconnection called "association" is required between the USB host and the USB devices. According to "Association Models Supplement to the Certified Wireless Universal Serial Bus Specification," Revision 1.0 (Mar. 2, 2006), the contents of which are hereby incorporated by reference, a "Cable Association Model" and a "Numeric Association Model" may be used for associating a host and devices.

The Cable Association Model requires a cable for connecting the host **110** and the DWA **130** or the devices **140** to **170**. The Numeric Association Model requires the devices **140** to **170** to each have a key pad. However, there typically is no key pad for input of numbers in devices such as a printer, a mouse, or a digital camera. Therefore, the use of the Numeric Association Model is limited.

Currently, the HWA **120** and the DWA **130** are needed to enable WUSB communication between the host **110** and the devices **140-170**. Enabling WUSB communication between the host **110** and the devices **140-170** without the HWA **120** and the DWA **130** would be more efficient.

FIG. **2** is a block diagram illustrating a USB system according to an exemplary embodiment of the present invention.

Referring to FIG. **2**, a USB system **200** includes a USB host **210** and a USB device **220**. The USB host **210** and the USB device **220** have configurations which are able to communicate through USB and WUSB, respectively.

The USB host **210** includes an internal circuit **211**, a WUSB interface **212**, an antenna **213**, and a USB connector **214**. The internal circuit **211** is configured to perform the functionality of the USB host **210**. For example, when the

host **210** is a personal computer, the internal circuit **211** may include a processor, a memory, a memory controller, a buffer, a clock generator, input/output device, and the like. The WUSB interface **212** provides an interface that enables the internal circuit **211** and the USB device **220** to conduct WUSB communication by means of antennas **213** and **223**, and/or USB communication by means of connectors **214** and **224**, respectively.

The USB device **220** includes an internal circuit **221**, a WUSB interface **222**, an antenna **223**, and a USB connector **224**. The internal circuit **221** is configured to perform the functionality of the USB host **210**. For example, when the USB device **210** is a digital camera, the internal circuit **221** may include a processor, a memory, a memory controller, a Digital Signal Processor (DSP), a buffer, a clock generator, an input/output device, and the like. The WUSB interface **222** provides an interface that enables the internal circuit **211** and the USB device **220** to conduct WUSB communication by means of antennas **213** and **223**, and/or USB communication by means of connectors **214** and **224**. The USB device **220** may include one or more portable devices, such as a personal digital assistant (PDA), MP3 player, portable video game, memory stick, and the like, or one or more computer peripheral devices, such as mouse, keyboard, printer, scanner, joystick, card reader, and the like.

In accordance with the USB system **200** of the present embodiment, at an initial association between the USB host **210** and the USB device **220**, WUSB communication is conducted by connecting the USB connector **214** of the USB host **210** and the USB connector **224** of the USB device **220**, exchanging connection context (CC) by means of USB communication, and disconnecting the connectors **214** and **224**. The configuration of the USB host **210** and the USB device **220** enables WUSB/USB communication without using a separate wire adapter, and is readily able to perform association.

FIG. **3** is a block diagram illustrating a configuration of the WUSB interface **222** of FIG. **2**, according to an exemplary embodiment of the present invention.

Referring to FIG. **3**, the WUSB interface **222** includes an interface module **310**, a WUSB module **320**, and an on-the-go (OTG) module **330**. As will be appreciated by those skilled in the art, the functionality of each of the modules may be implemented, for example, as software, logic circuits, or combinations thereof.

The WUSB module **320** interfaces for WUSB communication between the internal circuit **221** of FIG. **2** and an external device, such as the host **210**. The OTG module **330** controls the USB communication between the internal circuit **221** and the external device. The interface module **310** controls the WUSB module **320** and the OTG module **330** to perform a control function for smooth WUSB/USB communication between the internal circuit **221** and the external device.

As portable devices, such as PDAs (personal digital assistants), MP3 players, cellular phones, portable video games, and the like, become more prevalent, there is increasing demand for direct connection between such devices without using a personal computer. OTG-supplementation provides limited-host functionality to satisfy such demand. In other words, the OTG module **330** enables data transfer between peripheral devices, between a peripheral device and a portable device, or between portable devices, without using a separate host.

When the USB device **220** is connected with the host **210** by means of the USB connector **224**, the host **210** and the OTG interface **330** have a "host-device" relationship. Also, when the USB device **220** is connected with the host **210** by means of the USB connector **224**, or when the USB device **220** communicates through WUSB with the host **210** by means of the antenna **223**, the OTG interface **330** and the internal circuit **221** of the USB device **220** have a "host-device" relationship. In other words, the OTG interface **330** is designed to operate as a "host" or a "device," according to the operation mode.

In accordance with the exemplary embodiment of the present invention, when the connector **224** of the USB device **220** is connected to the connector **214** of the host **210** for association, the host **220** and the internal circuit **221** in the USB device **220** communicate in a USB manner by means of the OTG module **330**. After the association operation is completed, the internal circuit **221** of the USB device **220** communicates using WUSB with the host **210** by means of the antenna **223**. Here, the interface module **310** in the WUSB interface **222** controls incoming signals such that a signal received from the antenna **223** is transferred to the internal circuit **221** through the WUSB module **320** and the OTG module **330**, in this order. On the other hand, the interface module **310** controls outgoing signals such that a signal output from the internal circuit **221** is transferred to the host **210** through the OTG module **330** and the WUSB module **320**, in this order.

FIG. **4** is a flow diagram illustrating an association process of the USB system of FIG. **2**, according to an exemplary embodiment of the present invention.

Referring to FIG. **4**, host **210** and device **220** are associated for a WUSB communication between the host **210** and the device **220**. In order to make the association, the connector **224** of the device **220** is connected to the connector **214** of the host **210**. This connection may be initiated, for example, by a user. When the host **210** recognizes that the device **220** is connected, it inquires the user whether to perform association between the device **220** and the host **210**. When the user accepts or authorizes the association, connection context (CC) is exchanged between the host **210** and the device **220**. For example, as described in "Wireless Universal Serial Bus Specification," Revision 1.0 (May 12, 2005), the contents of which are hereby incorporated by reference, the CC may include connection host ID (CHID), connection device ID (CDID), and connection key (CK).

In an embodiment, the above-described authorization process may be performed, for example, when a specific button (not shown) of the device **220** is pushed or otherwise selected by the user. In other words, when the host **210** recognizes the connection of the device **220** and inquires whether to perform association, the user may express authorization by pressing the specific button of the device **220**. In other exemplary embodiments, the user may authorize association using input devices, such as a key pad or mouse connected to the host **210**.

Also, in other exemplary embodiments, the authorization process steps of FIG. **4**, asking to the user whether to perform association with the device **220** and waiting for the user's authorization, may be omitted. In other words, when the device **220** is connected to the host **210**, like the PnP function, the host **210** automatically carries out CC exchange with the device **220** for association.

When the CC exchange between the host **210** and the device **220** is completed, the user may separate the device **220** from the host **210**. Then the host **210** and the device **220** are able to perform WUSB communication.

The USB device of various embodiments of the present invention thus enables WUSB communication with the host without using a wire adapter. Furthermore, the USB device may readily form association with the host.

FIG. **5** is a block diagram illustrating a USB system, according to another exemplary embodiment of the present invention.

Referring to FIG. **5**, a USB host **510** and a USB device **520** have similar configurations as the USB host **210** and the USB device **220** of FIG. **2**, respectively. That is, internal circuit

511, WUSB interface 512, host antenna 513, internal circuit 521, WUSB interface 522 and device antenna 523 may be configured similarly to internal circuit 211, WUSB interface 212, host antenna 213, internal circuit 221, WUSB interface 222 and device antenna 223, respectively. However, the USB host 510 and the USB device 520 connect by means of a USB dongle 530, instead of through connectors 214 and 224, as shown in FIG. 2.

The USB dongle 530 includes an interface circuit 531 and a connector 532. The interface circuit 531 is configured to enable CC exchange with the USB host 510 and the USB device 520. When the USB device 520 is a large-sized peripheral device, such as a printer or a scanner, for example, it may not be easy to directly connect the device 520 to the host 510 for association. Therefore, the USB dongle 530 of the present embodiment includes circuit configuration for CC exchange, and enables association between the USB device 520 and the USB host 510 by connecting the USB dongle 530 to the USB host 510 and the USB device 520 alternately, instead of directly connecting the USB device 520 to the host 510.

FIG. 6 is a flow diagram illustrating an association process of the USB host 510 and the USB device 520 using the USB dongle 530 of FIG. 5, according to an exemplary embodiment of the invention.

Referring to FIG. 6, the dongle 530 is connected to the host 510 through connectors 532 and 514, respectively, to make the association. This connection may be initiated, for example, by a user. The host 510 recognizes that the dongle 530 is connected and asks the user whether association may be made with the dongle 530. When the user accepts or authorizes the association, the host 510 performs CC exchange with the dongle 530, which stores the CC information in a memory (not shown). In other exemplary embodiments, it is possible to skip the authorization process of asking the user whether to make association and accepting association by the user, and to carry out the CC exchange automatically.

When the CC exchange between the host 510 and the dongle 530 is complete, the user may connect the dongle 530 to the USB device 520 through connectors 532 and 524, respectively. The USB device 520 refers to the CC information stored in the dongle 530, enabling it to perform WUSB communication with the host 510.

The interface circuit 531 included in the dongle 530 may be designed to have a configuration similar to that of the WUSB interface 222, for example, as shown in FIG. 3. In another exemplary embodiment, the interface circuit 531 included in the dongle 530 may be configured only to conduct CC exchange. When the interface circuit 531 included in the dongle 530 has a similar configuration to the WUSB interface 222 of FIG. 3, the USB device 520 may communicate through WUSB with the host 510 through either the WUSB interface 522 or the interface circuit 531 in the dongle 530.

As described above, when the device 520 is a large-sized peripheral device, such as a printer or a scanner, for example, the association between the USB device 520 and the USB host 510 may be performed more conveniently by connecting the USB dongle 530 to the USB host 510 and the USB device 520 alternately, instead of directly connecting the device 520 to the host 510.

While the present invention has been shown and described in connection with exemplary embodiments thereof, it will be apparent to those skilled in the art that various modifications can be made without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A Universal Serial Bus (USB) device comprising:
an internal circuit; and
an interface circuit configured to interface between the internal circuit and an external device for wireless USB (WUSB) communication and USB communication,
wherein the interface circuit comprises:
a WUSB module enabling the WUSB communication;
an on-the-go (OTG) module enabling the USB communication; and
an interface module configured to selectively control the WUSB module and the OTG module to interface between the internal circuit and the external device for the WUSB communication and the USB communication.

2. The USB device of claim 1, further comprising:
a USB connector configured to connect the external device and the OTG module.

3. The USB device of claim 2, wherein the external device comprises one of a host or a device capable of performing the WUSB communication.

4. The USB device of claim 3, wherein the USB device exchanges connection context (CC) with the external device, when the external device and the OTG module are connected by the USB connector.

5. A Universal Serial Bus (USB) system comprising:
a USB device configured to be connected to a USB host; and
a dongle configured to connect with each of the USB host and the USB device, the dongle connecting to the USB host to exchange connection context (CC) with the USB host, and connecting to the USB device to provide the exchanged CC to the USB device,
wherein the USB device comprises:
an internal circuit; and
an interface circuit configured to interface between the internal circuit and the USB host for wireless USB (WUSB) communication and between the internal circuit and the dongle for USB communication.

6. The USB system of claim 5, wherein the interface circuit of the USB device comprises:
a WUSB module configured to enable the WUSB communication;
an on-the-go (OTG) module configured to enable the USB communication; and
an interface module configured to selectively control the WUSB module and the OTG module to interface the internal circuit with the USB host and the dongle for the WUSB communication and the USB communication.

7. The USB system of claim 6, wherein the interface circuit of the USB device further comprises:
a USB connector configured to connect the OTG module to the dongle.

8. The USB system of claim 7, wherein the USB device is configured to exchange the CC with the dongle, when the dongle and the OTG module are connected by the USB connector.

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